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Novel catalyst systems for deNO_x

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1. What is NO_x?

Nitric oxides are highly reactive gases; primarily NO (>90 %) and NO₂, involved in many pollutant processes e.g. the formation of acid rain

They are produced as a result of high temperatures during the combustion of fuels, and legislation is in place to control emissions i.e. the Industrial Emissions Directive (IED) regulates activities that involve burning or gasification of waste (Figure 1)

Technologies have been developed which react a reductant with NO_x emissions, forming harmless N₂ and H₂O. Development of a material and process to treat NO_x emissions using H₂ is the aim of this project

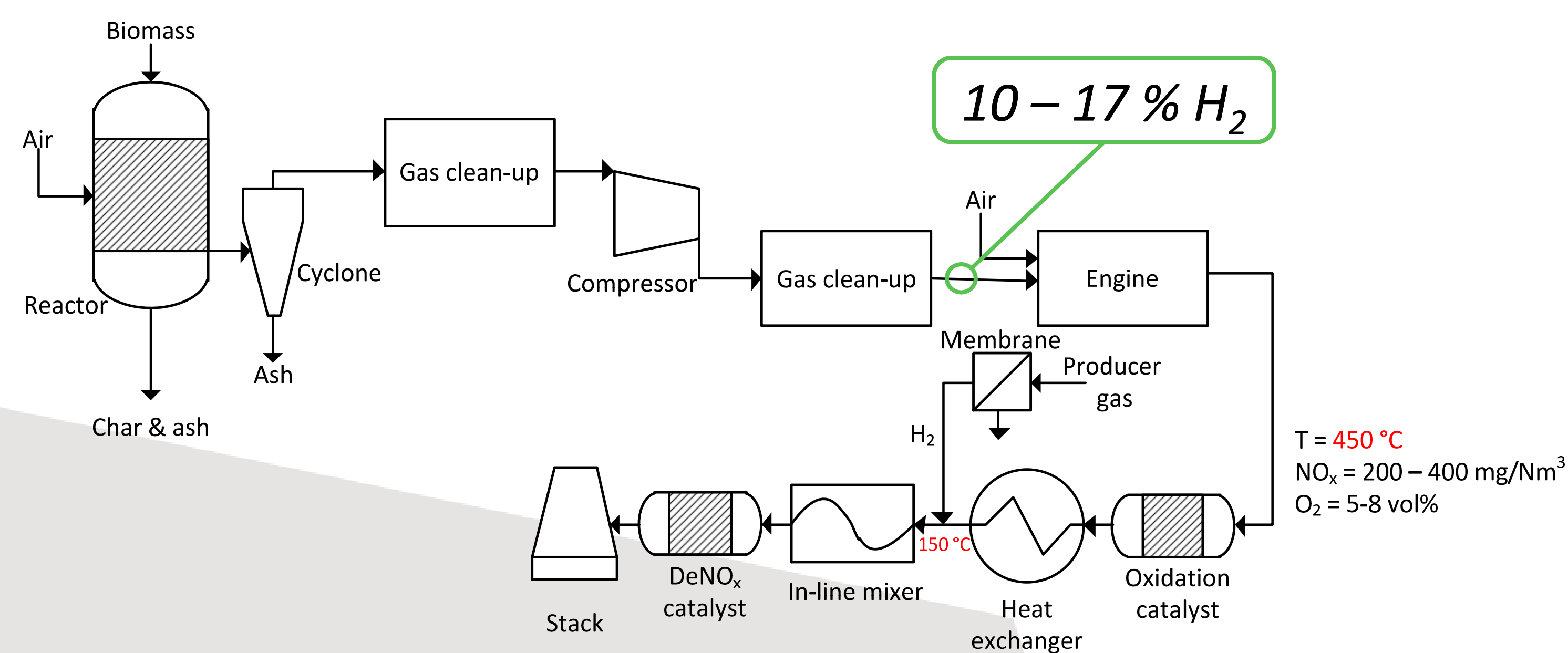


Figure 1. Schematic of proposed biogas engine exhaust treatment system

2. H₂ for deNO_x

Measurements made on an operational gasification plant (Figure 2), identified the gaseous fuel produced as having a 10-17 % H₂ content depending on the conditions in the gasifier

Utilising H₂ already present in the system (Figure 1) could provide a reductant which does not have to be specially manufactured (e.g. NH₃, urea), and hence would be a cleaner approach

H₂ can also be used in NO_x storage and reduction (NSR) processes where NO_x species are 'trapped' before they are subsequently reduced through alternate lean and rich-burn cycles



Figure 2. Refgas gasification plant, Chester, UK

3. Catalysts

Catalysts prepared using impregnation techniques (Table 1)

Supported on honeycomb monoliths (Figure 3)

Channel size = 1 mm x 1 mm (~80 channels per monolith)

Table 1. Summary of prepared H₂-deNO_x catalysts and associated processes

H ₂ -SCR	H ₂ -NSR
Pt/Al ₂ O ₃	Pt/Ba/Al ₂ O ₃
Ag/Al ₂ O ₃	Pt/K/Al ₂ O ₃
	Ag/Ba/Al ₂ O ₃
	Ag/K/Al ₂ O ₃

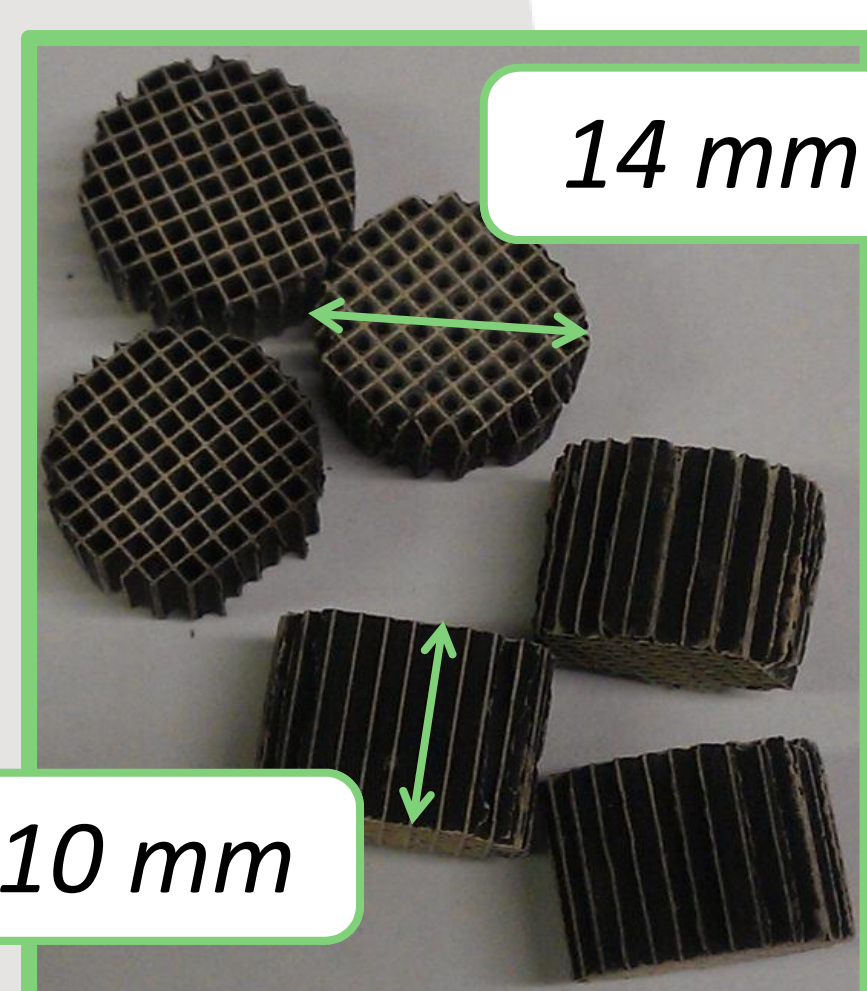


Figure 3. Pt/Al₂O₃ monoliths

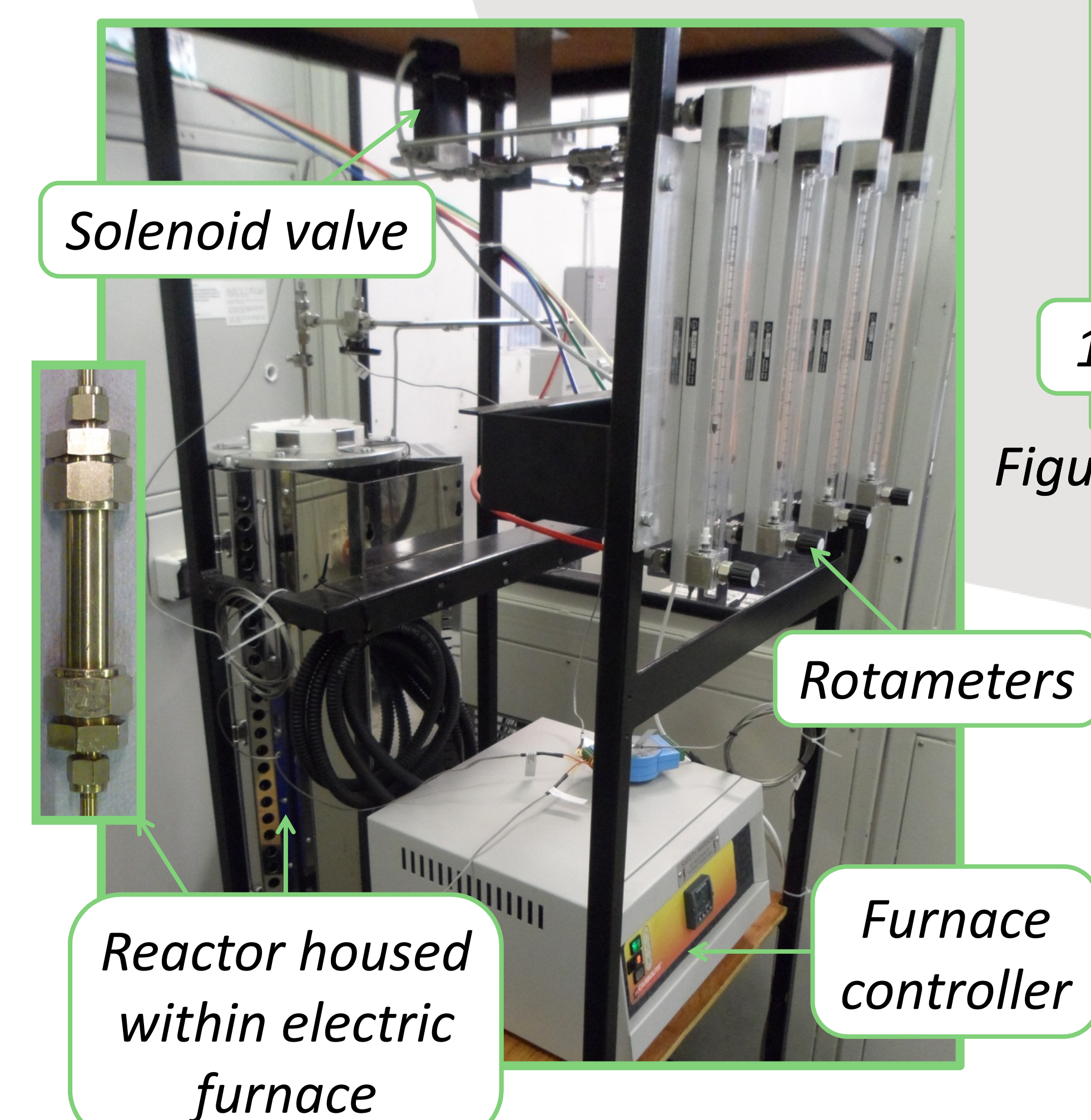


Figure 5. Experimental set-up

4. Preliminary Results

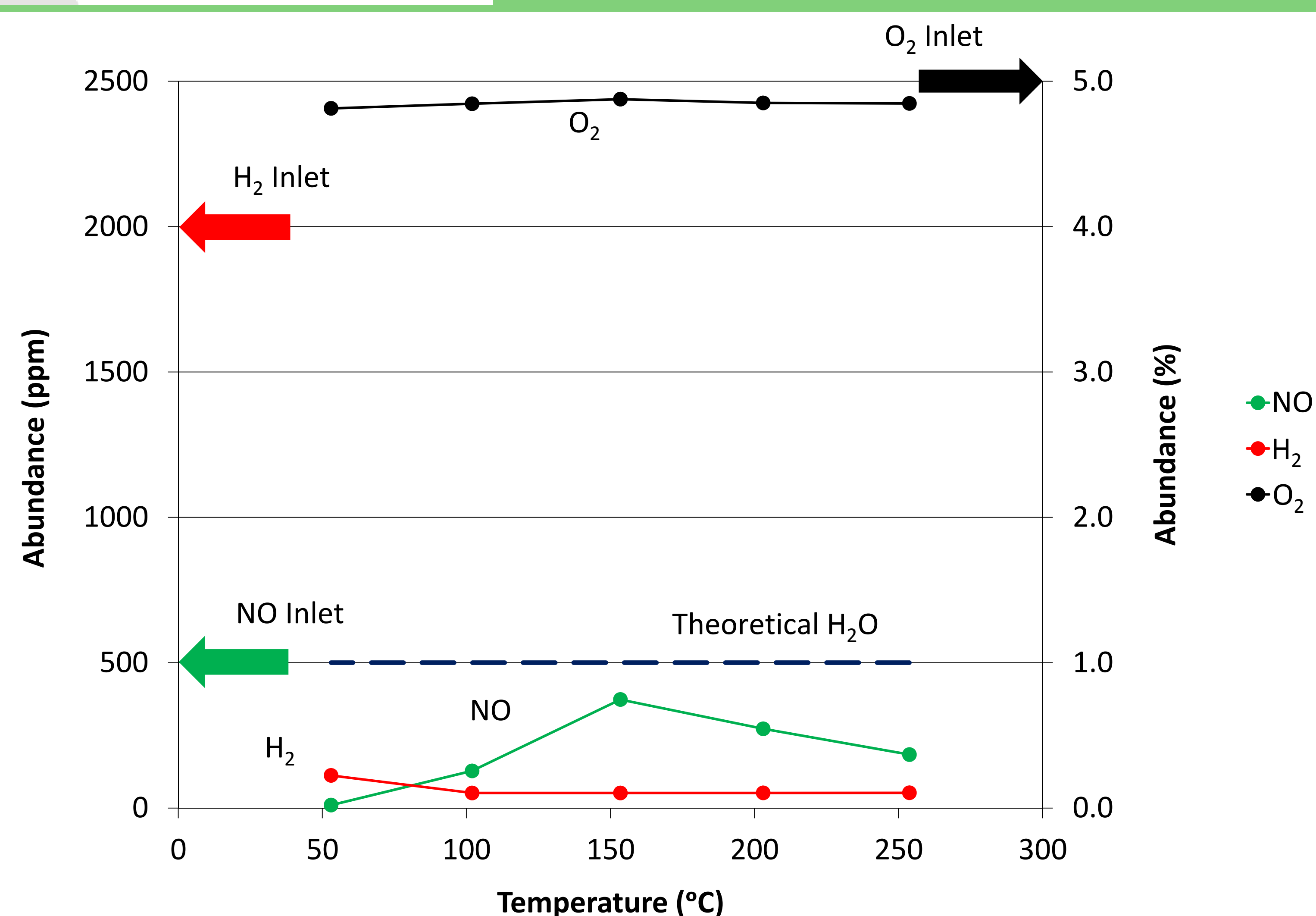


Figure 4. Example of data obtained from H₂-SCR over Pt/Al₂O₃ catalyst. Reaction conditions: 500 ppm NO, 2000 ppm H₂, 5 % O₂, balance N₂

5. Initial Conclusions and Future work

Initial results (Figure 4) suggest that catalysts demonstrate some deNO_x activity and in the presence of O₂, there is some competition between reduction and oxidation reactions (additional formation of NO₂ not shown)

Further work will investigate the performance of the prepared catalysts in their relevant processes (SCR/NSR) and identify optimum conditions/limitations. The catalysts will be characterized through temperature-programmed studies (TPD and TPSR)